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UNIT COSTING IN THE SHIPYARD ENVIRONMENT

by

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A model of shipyard operations is proposed and compared to theory. Questions of output measure and quality are addressed under the model. Dangers of output comparison are illustrated by example. The validity and limits of unit cost theory are established by applying the shipyard model.

A practical investigation into the applicability of the unit cost system to government operations focuses on elasticity, budget variability and performance evaluation.

This study concludes that unit costing alone is not sufficient to meet stated objectives. Additional incentives and increased autonomy are required to meet efficiency goals.

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by

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ABSTRACT

Unit costing is the latest initiative to achieve savings in DOD. Shipyards, which operate on a cost per unit system, illustrate the potential gains and hazards of unit costing.

Economic theory is applied to provide a basis of comparison for shipyard operations. Unit cost theory is illustrated along with definitions of controllability, scale and efficiency.

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TABLE OF CONTENTS

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I. INTRODUCTION

There is a movement gaining strength to bring free-market initiatives into the government reform process. This trend is visible in all areas of government, but nowhere more so than in the military. Due to its size, the military has always been under pressure to increase productivity in order to free capital for spending on domestic concerns. These pressures usually originated outside the Department of Defense (DOD) in congressional committees or reformist "think tanks". Recently, however, senior staff within DOD and the Office of the Secretary are viewing management reform as a way to meet the challenges of shifting mission priorities and shrinking resources. While previous efforts to streamline the military have centered on greater regulation and tighter control, the free-market reforms currently being discussed would reduce some of these restrictions. The question which arises is how well the free market can be applied to government operations in general and the military in particular.

Fallows [1] speaks of a "managerial" approach to the military. It is the desire to treat defense as a straightforward and efficient business using economics and management science. The shortcoming of this approach is in its inability to distinguish between technical or economic efficiency and mission effectiveness. Specifically, this results from the use of oversimplified one-dimensional forms of analysis. The origin of this methodology can be traced back to the end of World War II.

With the Hoover Commission report in 1949, the government began to shift away from expenditure control and toward performance budgeting. The goal of this approach was to improve the operational efficiency of government institutions. Cost accounting and work measurement initiatives were developed to support this effort. Unit costing first appeared in discussions during this period. These efforts went on for twenty years before culminating in the 1960's. In 1961 specific planning guidance was incorporated into the evolving defense management system to form the Planning Programming and Budgeting system (PPB).

The primary focus of PPB is stated to be planning, with opportunity costs at the margin acting as the primary driver. The system is intended to rationalize policy-making by providing cost and benefit data for alternative planning and by providing output measures to evaluate whether chosen objectives are attained. A comparison of performance budgeting and PPB in LaCivita and Pirog [2] leads to the conclusion that performance budgeting and unit costing, if used correctly, could promote efficiency in existing operations while marginal analysis determines whether alternate activities could obtain desired objectives more efficiently. In an era of rapidly decreasing defense budgets, consolidation and base closure, it seems that planning should be the focus with marginal costs serving as the primary analysis tool.

Two schools of economists, however, argue that marginalism is inadequate as an analysis tool. The institutionalist school of American economists insists that economic actions can only be understood within the framework of history and contemporary laws, customs and attitudes. The radical political economists are also concerned with the fact that marginal analysis ignores history and present institutions and concerns itself too narrowly with the mechanics of choice. The author believes that marginal analysis is the only "rational" tool for economic analysis and will rely heavily on it in evaluating the theoretical basis for unit costing. However, in an effort to address the concerns of these other schools, "soft economics" will also be discussed in determining the appropriateness of unit costing to government operations. This effort will center on the unique nature of naval operations and the consumer environment.

A number of theories exist to explain consumer behavior, but the best known and most widely used is utility analysis. Utility analysis attempts to measure and predict satisfaction. Knowledge of consumers' total and marginal utility allows one to develop demand curves for those consumers. In the case of a naval shipyard, the primary consumers are the ships undergoing repairs, upgrades and maintenance. Their level of satisfaction is driven by a number of different elements such as price of the services, quality of workmanship, timeliness of job completion, technical competence and

capability, and convenience or availability. In a competitive environment, consumers would evaluate all these elements in deciding what work to have done at which installations.

Unit cost measures only the cost per unit of output or "bang for the buck." Decisions based primarily on these criteria run the risk of neglecting important considerations such as method of employment, support and mission effectiveness. While there is stated intent to incorporate performance and quality measures into the unit cost system, current measures consider only financial information.

The theory behind unit costing is that products and services should bear their full cost, including overhead. By instituting some limited market choice within the military, low cost providers will be rewarded with increased volume. Cost savings are expected to result as customers re-allocate their demand to the cheapest sources. For producers, cost reduction will become a primary area of interest to commanders. The unit cost financial information is expected to reveal the cost drivers, allowing commanders to reduce them more effectively. It is expected that unit cost will improve operations, allow for the evaluation of performance and budgets, support budget decisions and sanction work re-allocation decisions.

Unit cost is supposed to focus the manager and policy maker on the internal workings of an activity and its costs of doing business. Marginal analysis, on the other hand, allows policy makers to evaluate multiple sources of production. Chapter II will explore these two measures and develop the economic theory behind them. This development will include discussions of economies of scale, technical and economic efficiency and the variability of inputs. An economic model will be proposed against which a naval shipyard will be compared.

In Chapter III, the "soft economics" referred to above will be addressed in discussing the adequacy of unit cost measures. Limitations of unit cost theory will be demonstrated through the use of examples. Parallels to shipyard operations will be drawn in the discussion highlighting advantages and dangers in the system and discussing the role of proposed unit cost system changes.

Chapter IV will specifically discuss the application of unit cost theories in government operations. The issue of consumer choice in the military setting will be reviewed as well as the applicability of several proposed goals of the unit cost system. These include the topics of variability in budgets and the use of economic data for personnel evaluation.

This thesis will furnish the reader with a development of unit cost economic theory and a model to apply to government operations. That model will be matched against an operating naval shipyard. The appropriateness of this model will be discussed as well as several other issues incorporated into the Navy's unit cost system. Upon conclusion, it will be seen that the unit cost system is well intentioned but currently includes a great many hidden dangers to both cost performance and mission readiness. Further development of this program is needed before it can be effectively implemented in the fleet.

II. ECONOMIC THEORY

A. OPERATING IN THE SHORT RUN

Any business, including a Navy shipyard, is characterized by a certain size or capacity. Commitments, such as material contracts, personnel contracts and land leases, limit the flexibility of the firm. Three time frames characterize the restrictions placed on a firm. In the short run, at least one of the primary inputs cannot be varied. To change output, the firm adjusts its valuable inputs, holding its fixed inputs constant. In the long run, all of the inputs can be varied. New plants can be built to increase production and workers can be cut to lower capability and expense. In the very long run new technology can enter the marketplace altering the production function itself.

In reality, Naval commands are very restricted in the short run. To illustrate, Mare Island Naval Shipyard requested a reduction in force (RIF) in May 1992 to reduce overhead. The reduction was to take effect on 13 November 1992. As of the beginning of December 1992, no action had been taken on the request by higher authority. In short, the shipyard has been unable to alter the level of the primary input (labor) over the time frame considered, that being the budget cycle.

Thus, military personnel is essentially a fixed input to the shipyard. A plan exists to cost military personnel only at the lower civilian rate if they are in a billet solely for career progression or rotational purposes. The fact remains, however, that these billets can not be readily eliminated. In fact, the shipyard at Mare Island is forced to take a charge against unit cost for military billets currently unfilled.

The distintion between fixed and variable costs has important implications for managers. The unit cost system, however, implies that all costs are variable. One of the supposed advantages of the unit cost concept is that the budget automatically fluctuates with changes in workload. This is intended to remove uncertainty from the budget process. The problem is that all costs of operation

are not variable. In fact, the majority of expenses are not variable at many Naval installations. At Mare Island Naval Shipyard, the comptroller reports that personnel costs account for approximately seventy percent of the unit's total expenses. While much of this personnel cost would be considered a variable cost by economists, it is not controllable to local management as discussed above. If half of the remaining expenses, (property maintenance, depreciation and other G&A expenses) are truly fixed in the economic sense of the word, then over eighty-five percent of the total expenses do not fit the unit cost model.

The Unit Cost Resourcing Guidance [3] states that future efforts will attempt to better identify fixed and variable costs. Until this is accomplished, however, the system remains critically flawed.

B. COSTS

To ellaborate on the distinction between cost categories, the total short run costs for a business can be divided into *total fixed cost* and *total variable cost*. Total fixed cost does not vary with the level of output. The total variable cost does change with any change in output or workload. Figure 1 shows a typical representation of these costs [4]. Note the shape of the total variable cost curve. Total variable cost initially increases at a decreasing rate with production as economies of scale are realized. Eventually, however, variable cost increases more rapidly as diminishing returns set in.

From the curves of Figure 1, we can derive four new measures in the short run; *average fixed cost*, *average variable cost*, *average total cost* and *marginal cost* [4]. Average fixed cost is simply the total fixed cost divided by output. It decreases with volume. Average variable cost is the total variable cost divided by output. The average variable cost falls during early levels of production and rises at high levels of production. The average total cost is the sum of average fixed and average variable cost. The average total cost (ATC) curve is also known as the unit cost curve. The

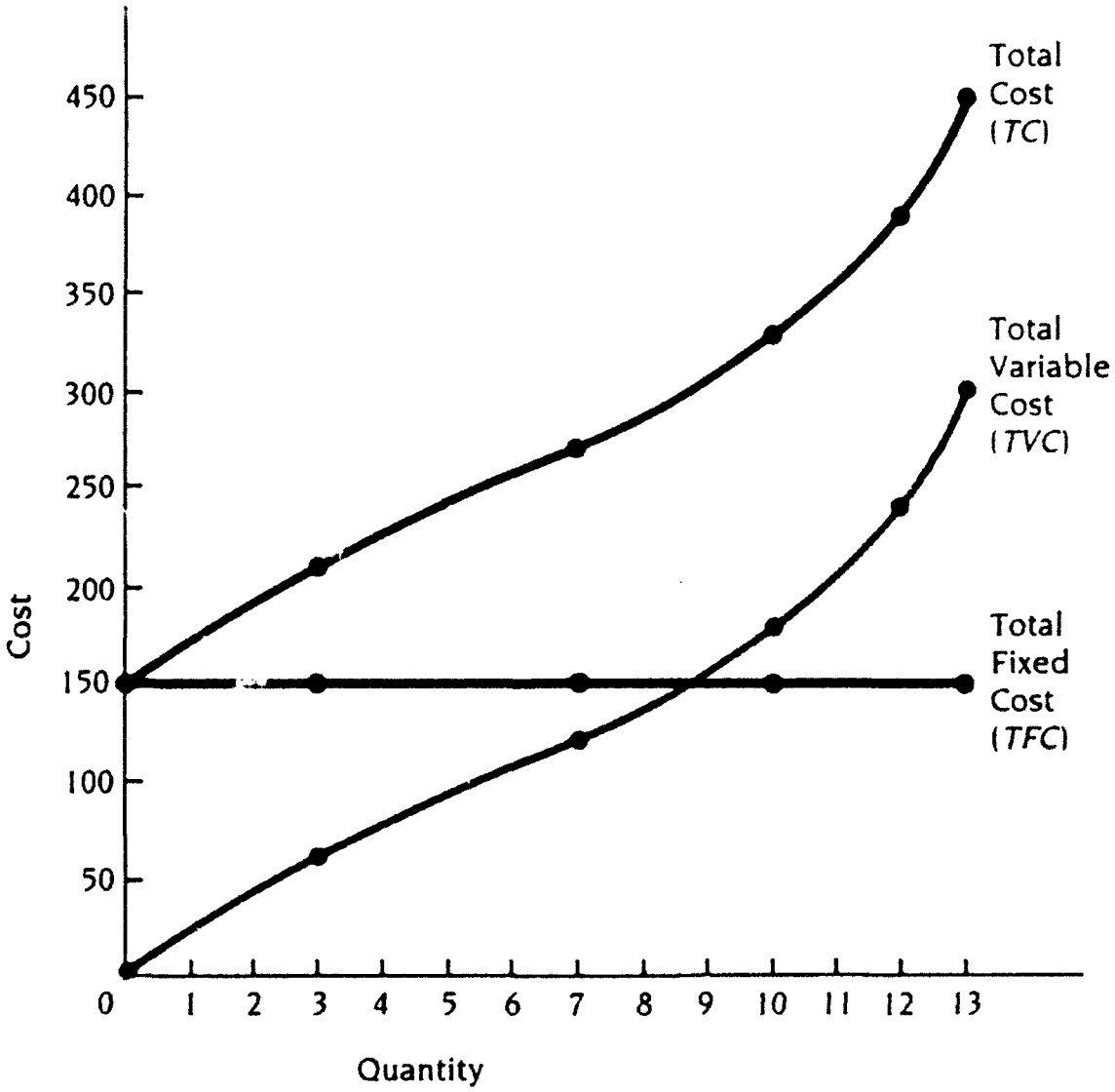

Figure 1. Total cost curves

relationship between these curves in given by Figure 2 [4]. One of the dangers of basing decisions on unit cost is demonstrated by the "U" shape of the curve ATC curve. The "U" shape is the result of the interaction between fixed costs and the law of diminishing returns. Average fixed costs decrease as output increases leading to the initial downward slope of the curve. Eventually, however, the maximum efficiency point is reached and further production requires greater increases in variable inputs for each additional unit of output. This will be further discussed under diseconomies of scale. A firm on the upward sloping portion of the curve must actually lower production to lower its average total cost.

A vital tool neglected by unit costing is the marginal cost of production. The relationship between marginal cost, average total cost and average variable cost is shown in Figure 3 [4]. Marginal cost is derived by dividing the differential input cost by the differential output produced. The marginal cost curve is also "U" shaped. It can be seen from Figure 3 that the marginal cost curve intersects the average total cost curve and the average variable cost curve at their lowest point. This is the key point in efficiency analysis and the critical flaw in unit costing. Obviously, when choosing between numerous firms for increased production, the firm which should be chosen is the one with the lowest marginal cost, or the one which will cost the least for the additional unit of production. This may very well not be the firm with the lowest average total cost or average variable cost.

C. ECONOMIES OF SCALE

In the long run, firms can operate in any one of three environments, economies of scale, constant returns to scale and diseconomies of scale. In many cases, a firm with larger production capacity can achieve lower average cost than a small volume operation. However, its advantage does not last forever. Eventually, constant returns set in and larger plant size no longer provides lower average cost. Plants which are too large can even demonstrate higher average costs.

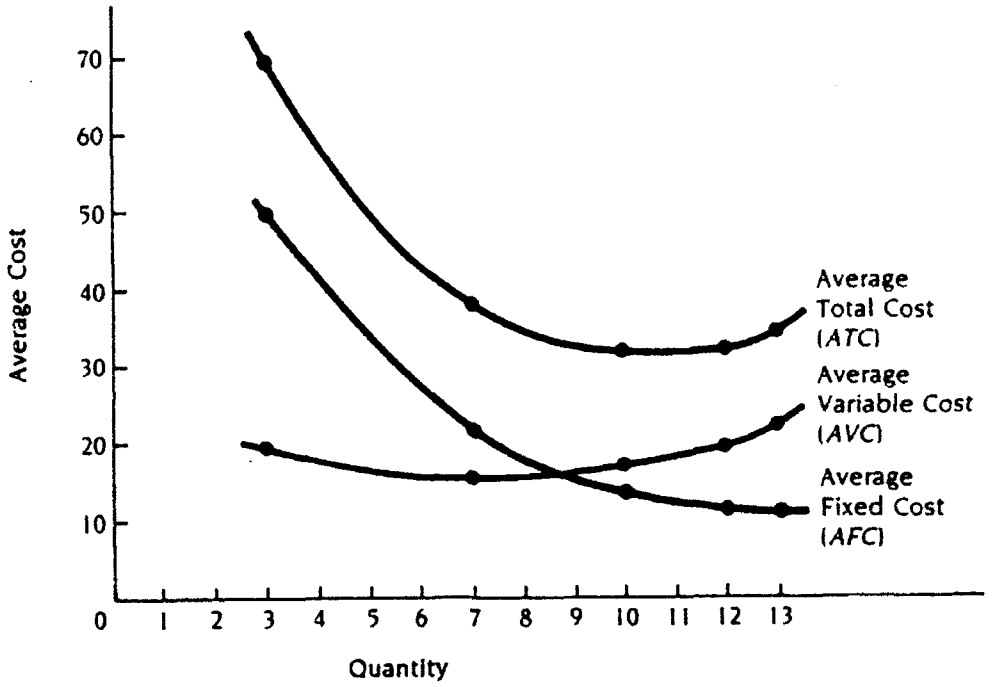

Figure 2. Average cost curves

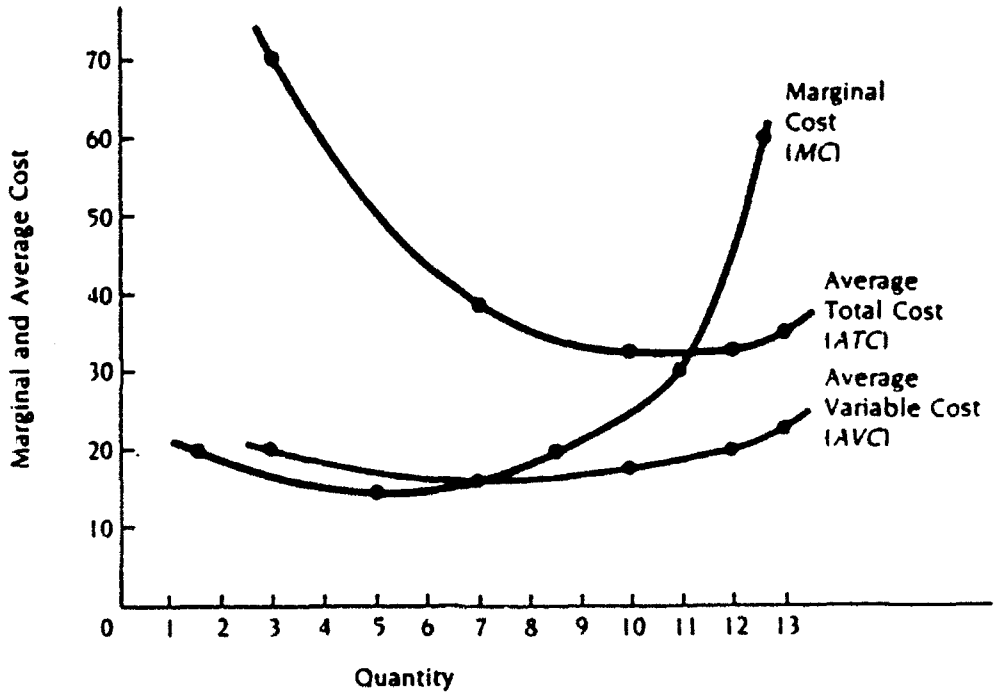

Figure 3. The marginal cost relationship

Figure 4 [4] illustrates total, average and marginal costs for economies of scale. Note that the marginal cost is constantly decreasing. This results from constantly increasing production efficiencies and decreasing average fixed costs as discussed above. This can be visualized by considering a factory and assembly line. As more workers are added, they can pass work from one to another more easily on the assembly line and increase productivity. This concept is a crucial element in production allocation decisions. The same information is shown for constant return to scale in Figure 5 [4]. Here the average and marginal costs are equal for all points. This must be so since average cost is neither increasing or decreasing.

Diseconomies of scale appear in Figure 6 [4]. In this example, rising marginal cost leads increasing average costs and total costs. Over-expanded facilities may increase support costs or have physical properties which limit effectiveness at high volumes. This can be explained by again considering the factory but with limited floor space. As units of production are added and more workers are hired, the line becomes more crowded. Eventually the line will become so crowded that workers will get in each others way and productivity will actually begin to decrease.

The resourcing guidance does state that it "may be desirable" to recognize cost differences associated with the size of an activity. Obviously, larger activities with greater capital investment will often report higher unit costs than small activities for lower output volumes. This difference is critical when determining unit cost goals for an organization. While individual commanders operate in the short run, the limitations placed on them are determined by long run considerations. Shop capacity and infrastructure dictate a large portion of the overhead rate at any installation. Not all activities will be able to reach the same unit cost goals, and allowances for each situation must be made.

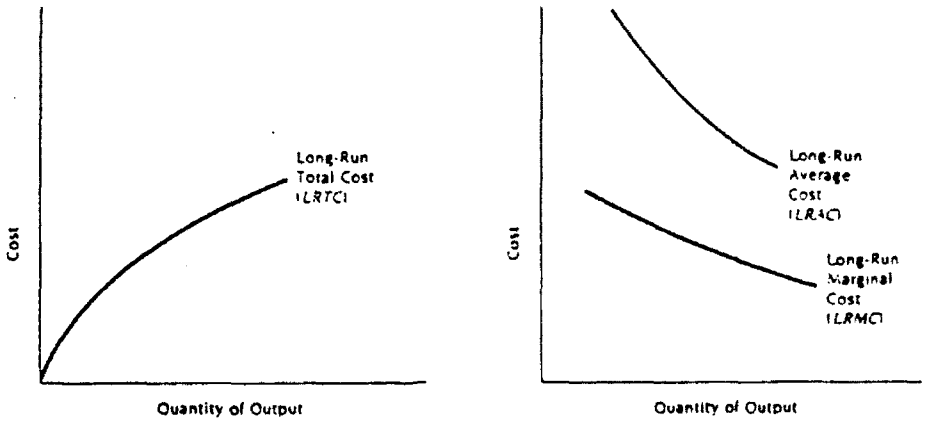

Figure 4. Long-run costs for economies of scale

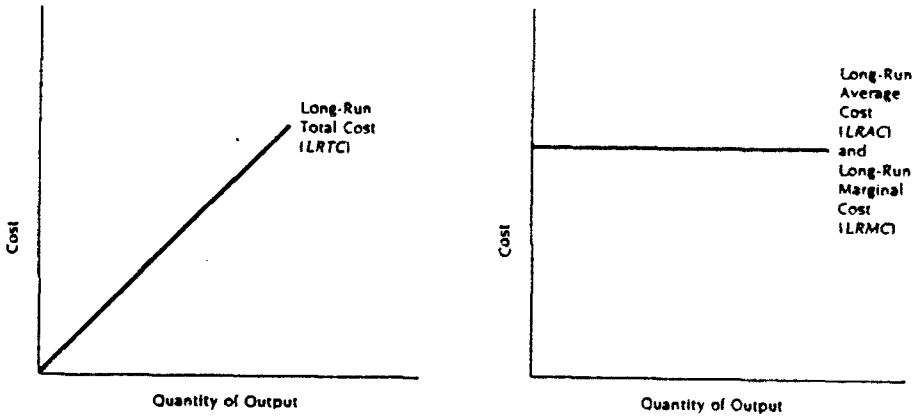

Figure 5. Long-run costs for constant returns to scale

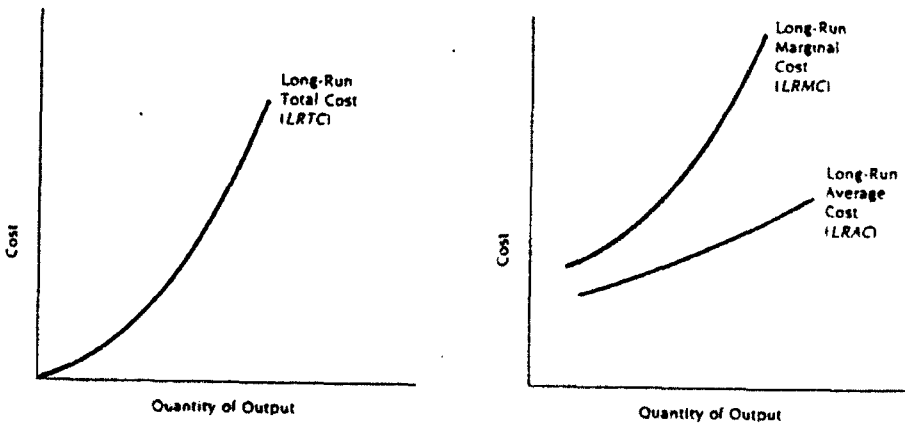

Figure 6. Long-run costs for diseconomies fo scale

D. EFFICIENCY

A production function shows the maximum output which can be produced for a given level of inputs. In effect, it states the constraints on production, usually in terms of labor and capital. The production function is unique to each producer and is dependent on the resources available to the producer at the time of interest. The production function can be changed in the long-run, but not in the short-run.

The production function also describes a set of alternative input combinations which are said to be *technically efficient*. A technically efficient combination means that there is no waste of resources. No other method of production will result in the same output without using more of one input. There are, however, many technically efficient means of achieving the same output. The combination desired is that which is *economically efficient*. An economically efficient alternative is the technically efficient alternative with the output levels where marginal benefit equals marginal cost. A shipyard commander may employ his resources in a technically efficient manner but be unable to employ them in an economically efficient manner.

E. MODEL

Navy activities can best be characterized as oligopolies. These are seller's markets which are made up of a few firms producing anywhere from standardized to very differentiated products with varied levels of barrier to entry. The term "few" denotes an interdependence among firms. Each is affected by the actions of the others.

Level of output and price in an oligopoly are not determined by examining only consumer demand and product cost. A level of gamesmanship enters the picture driving producer decisions. Market share, competitor response and government procurement rules all come into play. Figure 7

illustrates an oligopolist earning a long run economic profit [4]. This figure is very similar to a monopolist's profit. The difference lies in the derivation of the demand curve.

While the demand curve is expected to be more elastic than in a pure monopoly, and less so than in industries with several competing suppliers, there will be an enormous amount of price rigidity in an oligopoly. Firms are typically risk adverse and reluctant to disturb the status quo. Disturbing the status quo may energize their competitors and the ultimate outcome is uncertain. Often advertising and product or service changes are implemented rather than price changes in this market. Selling superior service is much safer than lowering price because it avoids directly affronting a competitor. There is typically enough competition in oligopolistic markets to force producers to produce on their average-total-cost curve (i.e., technically efficient).

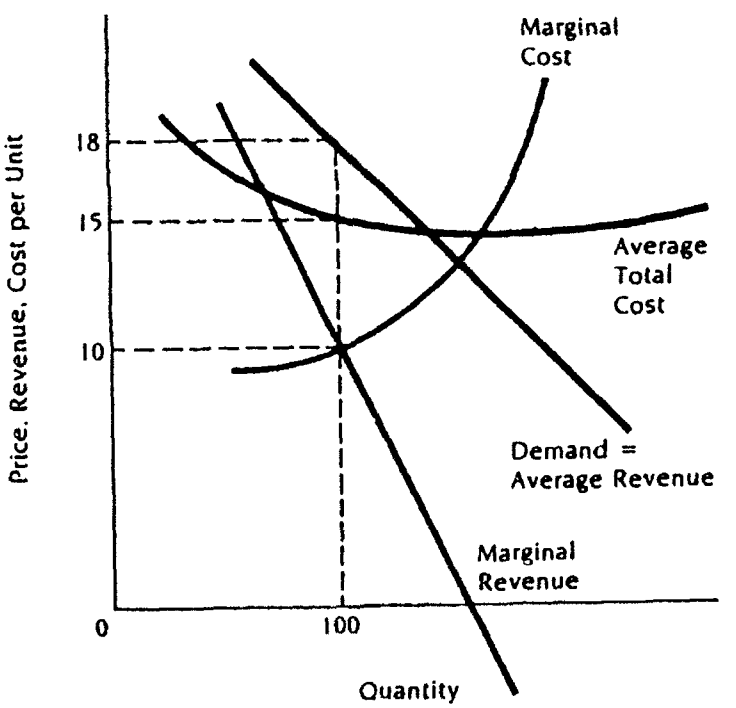

Figure 7. Oligopolist in long-run equilibrium

III. APPLYING THEORY

A. MEASURES

One troubling aspect of unit costing is the claim that it will allow managers to "measure the improved efficiency" in their organizations. This is a dangerous conclusion as it equates efficiency with the cost per unit of output. The trouble arises in determining a measurable output which accurately reflects the mission of the activity. Too much emphasis on cost may cause managers to reduce current cost at the expense of quality and cost reducing capital investment or distort production between primary and secondary outputs.

As an example, the Unit Cost Resourcing Guidance [3] defines the primary mission for Inventory Control Points as satisfying customer material requirements. The primary output measure used in measuring satisfaction is given as cost per dollar of gross stock fund sales. In a Navy dedicated to quality, how is quality reflected in an output measure of gross sales? There is no accounting for delivery times, adequate stockage, percentage of defective materials or percentage of incorrect transactions. Surely, these are all critical to satisfying customer material requirements. When ultimately servicing combat units, it can be persuasively argued that these elements are more critical to satisfying the mission than the cost of operating the control point.

A second example from the resourcing guidance mandates that each service assign unit cost goals to recruiting activities. Unless additional measures such as average ASVAB scores or education level are considered, a significant risk exists that recruiters will not take on extra expense to compete for top quality personnel in the marketplace. By relying too much on any cost measure, the service runs the risk of reducing the caliber of recruits just as downsizing forces greater reliance on each individual. The results of these actions may have significant long-term costs which overwhelm any short-term savings.

These questions and risks certainly pertain to the shipyard example. Repair or replace decisions are at the heart of the unit cost effort. It may often be cheaper, in terms of cost per manhour expended, to repair systems rather than replace them. Design services are not required for repairs. Neither are extensive supply orders or other support services which carry high overhead. This may not be the most efficient or effective choice though. Unit cost data implies that it is better to repair a unit numerous times rather than replacing it once, even if the total cost of the repair is higher. Each time the item is repaired, it lowers the shipyard average total cost, despite the fact that the total cost is rising beyond the replacement value. Further, the ship is left with a less reliable piece of equipment. It may seem cheaper to patch-up and patch-up an old car, but eventually, the costs will grow beyond the value of the automobile. Further, it will not be reliable and eventually it will fail catastrophically.

Shipyard operations do have the advantage of a separate enforcement mechanism for quality. During overhauls, a responsible member of the ships crew must certify that the job has been properly completed before it can be "signed off." While dispute may occasionally arise, the advocacy of the operation is a strong controlling force. Without such external mechanism, activities could achieve unit cost savings by lowering quality.

The issue of long-term costs becomes even more acute with the capital budget, including military construction (MILCON), operations and maintenance (O&M), research development test and evaluation (RDT&E), and procurement. Since capital budget expense is allocated in the same way as G&A, there is a strong incentive to reduce costs from these areas. This has dire implications for future software development and R&D efforts, as these endeavors usually require large investments which may not yield significant results during the tenure of the military personnel involved. Since there is no output measure for support of new cost saving measures, it seems inevitable that pressure to meet ever decreasing cost goals will force significant cutbacks in R&D. Any attempt to alter the production function in the very long run will only penalize managers as start-up and

development costs are reflected in the short run cost data. This shortcoming will only reduce the opportunities for greater savings and breakthroughs in the future.

Gates and Terasawa [5] address this conflict from an analytical standpoint. In perfect competition, firms cannot affect price. Therefore, all savings resulting over time from improved operations are retained as profit. Since the shipyard model is an oligopoly, however, changes in costs will affect prices. Further, since the allowable price will be adjusted downward with costs under unit costing, the profit incentive is reduced as well.

Augmentation and mobilization stocks in supply operations, and real-property maintenance projects in excess of $15,000, are also included in the capital budget. This is despite comments in the DBOF implementation plan report [5] which states that mobilization and surge costs are intended to be directly funded, thereby removing them from unit cost calculations. By including these expenses in the unit cost calculation, managers are forced to trade off maintenance and quality-of-life improvements against vital operational costs. These items are not equal in terms of funding flexibility or operational effect. They are, however, currently equal under the budget. Under the current guidance, operational commanders will have little choice but to attack maintenance in searching for savings just as with R&D. Again the question arises as to whether these actions are in the long-term interests of the force. Different funding categories exist specifically to avoid salvaging support elements in favor of a few more operational dollars or a lower unit cost. Without separate measures to insure adequate attention, this funding structure encourages commanders to neglect all considerations but the "bottom line".

The proposed unit cost system does acknowledge the presence of "primary" and "other" outputs. It is important to keep these separate so that altered demand for "other" outputs does not cloud the operating data with respect to the primary output. However, the controls currently in place are not sufficient to accomplish this. Since these outputs may or may not be related, a strong incentive exists to shift costs from the primary output to any others. In this way, commanders will look good

to superiors while distorting market relationships with others. The result is that activities using the secondary outputs will be forced to create unnecessary duplication in an effort to avoid paying for the overpriced services. At the same time, the producing activity is encouraged to expend efforts building markets for their secondary outputs in an effort to reduce their visible "primary" output costs. This draws operational commanders into budgeting "gamesmanship." Budget priorities are distorted and future development endangered in favor of short-term budget savings.

Mare Island's comptroller states that the shipyard is one cost center for unit costing purposes. Performance is measured by "grading" against a single rate, which equates to total costs (both direct and overhead) divided by total direct labor hours. Specifically, ATC = $\frac{L + K + E}{MH}$ where, L = labor dollars, K = direct capital and E = materials expense, all other overhead and G/A expense, and MH = manhours expended. All shops within the shipyard use the same acceleration rate for overhead but use different applied rates when accounting to the customer. While the shipyard is charging customers properly for the type of work done, staff is seeing only the composite results of all work. Obviously, the breakdown of work performed has an enormous effect on the total cost.

With the equation above, quick efficient repairs may acatually penalize the shipyard's unit cost. Manpower intensive jobs are much more desirable under this system because they spread capital material and overhead expenses over a larger base. The apparent incentive is for shipyard to "load up" on labor intensive jobs, and "pile on" manhours for each job to further spread expenses and lower unit cost.

The long range plan for unit costing is to incorporate performance and quality goals into the operating budgets. Monitoring these goals should limit the amount of gamesmanship involved in management. Unfortunately, it will also reduce the options available to managers in response to budget pressures. Current performance measures in the maintenance world include on time performance, funded backlogs and supply inventory measures. At this time, however, managers are unsure how any of these performance measures will be viewed in relation to the "bottom-line" unit

cost data. As more repair contracts become open to bid from civilian shipyards, the relative weight of these and other performance measures becomes even more critical.

B. COMPARABILITY

A key point to unit costs are that they are activity and output level specific. Comparisons between work locations are invalid. So too are comparisons between periods of differing workload at the same location. This leads to inevitable questions regarding how unit costing data will be used.

One concern is that, unit cost data will indeed be used to make improper comparisons leading to incorrect reallocation decisions. The *DBOF Implementation Plan Report* [6] lists the improved ability of congress to influence operations and exercise oversight as a major benefit of the program. Providing detailed operating data to congress seems to be an open invitation to greater micromanagement and distortion of resources. Once unit cost data enters the political arena, it is much more likely to be misused in justifying base closure positions, contract awards and other high stakes political decisions.

Further, if operational commanders are given greater opportunity to exercise control, they will certainly base decisions on comparisons of unit costs. These managers will not have access to marginal cost data, performance measurements or any inputs other than average total cost of a contract. This can lead to mismanagement of funds as described below.

C. EXAMPLES

Unit cost must be used with great care in reallocation decisions. Without extreme care, its use can lead to higher rather than lower total costs to a program. As discussed in Chapter II, the firm with the lowest ATC may not be the best choice for increased production, depending on the firm's marginal costs. This is demonstrated by the following examples from LaCivita and Pirog [2].

Let us assume that a firm operates on the unit cost curve of Figure 8 [2]. If that firm produces 120 units of output at a unit cost of $100, the firm will require a $12,000 budget. Should its required

output be reduced to only 60 units however, due to shifting needs or budget limitations, the unit cost rises to $140. A simplistic decision to cut the funding in proportion to output, from $12,000 to $6,000 would be disastrous. The firm will require at least $8,400 to function assuming efficient operation. The attempts by the Department of the Navy (DON) to achieve variable budgets by multiplying unit cost goals by projected output is doomed to failure. Assuming unit cost to be constant over any change in volume is wrong. Assuming it to be constant over the potentially large changes in volume projected due to declining force structure is dangerous.

Let us now try to compare two firms operating on the curve in Figure 8 [2]. This assumes that they produce the same product, have the same fixed costs and get the same productivity from their variable inputs. If firm A produces 120 units at $100 as above, the total cost of production is $12,000. If a firm B produces 200 units at a cost of $80 per unit, its total cost of production will be $16,000. The necessary budget then, to produce 320 units at the two facilities is $28,000. Since B has the lower unit cost, it seems only natural that money can be saved by switching production from A to B. This fallacy can be demonstrated by switching 60 units of production from A to B. A then retains production of 60 units at a unit cost of $140. Production at B will increase to 260 units, but the unit cost will increase as well to $100. The total output of 320 units now costs $34,400 or 22.86 percent higher with both unit costs above where they started. Shifting all production to B is an even larger mistake resulting in unit costs of $140 and total costs of $44,800 or 60 percent higher than to begin with. This figure does not even include any fixed costs from the remaining operation at A or the costs required to close the facility. As we know from the current base closure discussions, these costs can be quite significant.

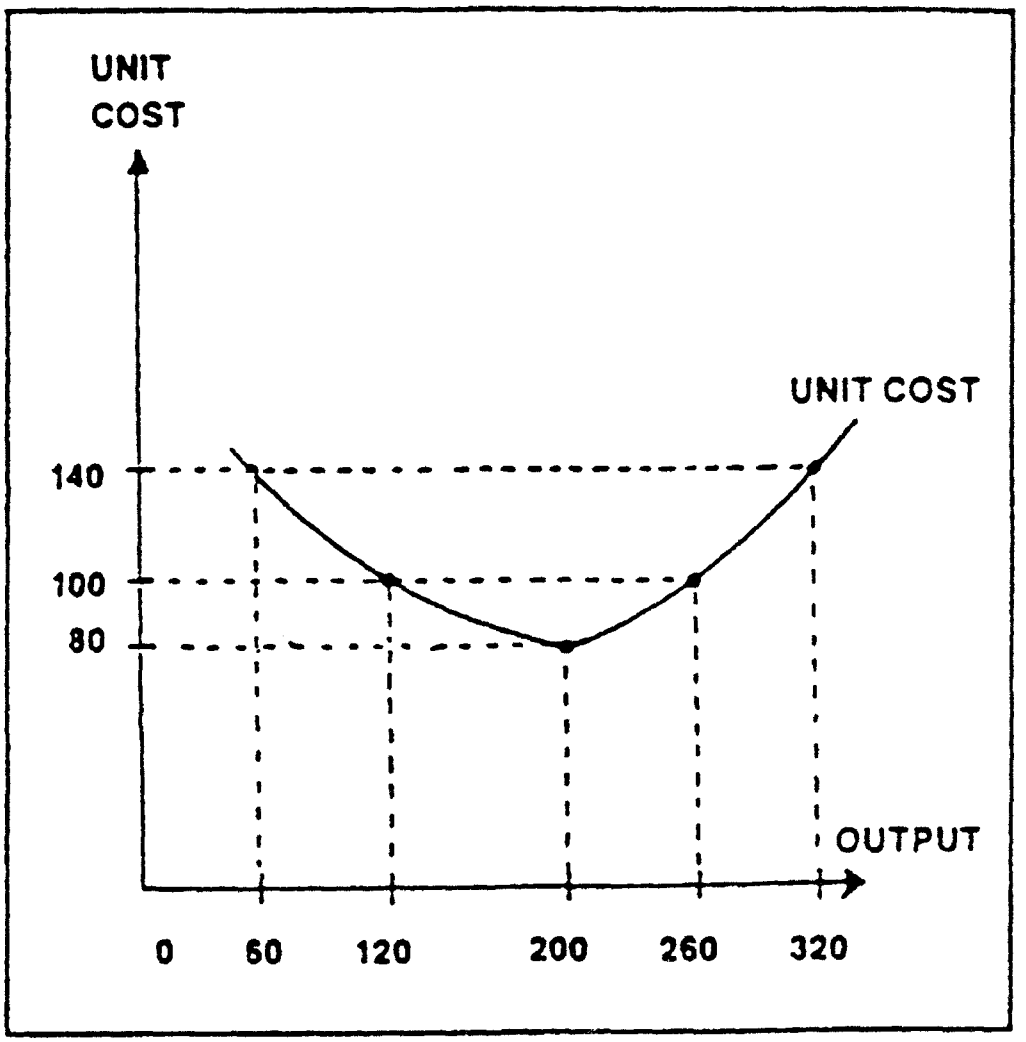

Figure 8. Unit cost example, two firms with identical unit cost functions

IV. APPLICABILITY TO GOVERNMENT OPERATIONS

A. ELASTICITY

While applying unit costing to government operations, there are several problems that should be considered. These include the incentives to minimize costs and maintain quality (as determined by the elasticity of demand and competition between suppliers), the variability of budgets, and the ability to use units costs to evaluate bases and managers.

It can be assumed that the demand for shipyard services, along with most other Navy services, is somewhat inelastic. While the ship's officers may elect to have the ship's crew repaint the work spaces or lay tile to save on the repair budget, most jobs leave no choice but to pay the set price and have the work done. The scale and complexity of work done is usually beyond the capability of the ship's force. Specialty tooling and training limit selection to one or two locations within the ship's area of operation. Foregoing repairs on equipment is not an option. Large scale availabilities are usually assigned at the Fleet Scheduling Conference each year. Once assigned, the schedule rarely changes, except in the case of overriding operational requirements.

Four elements determine elasticity. First is the availability of good substitutes. In the ship repair setting, there are usually no substitutes. There is no substitute for an operational forced draft blower to feed air to the boilers, or turbine generators to supply electrical power to the ship. In less severe cases, where substitutes might be available, regulations often prohibit their use. The second element is the percentage of available funds spent on a product or service. The lower the percentage of funds spent, the less elastic demand will be. The items for which substitution or cutbacks might be allowed are generally small, relatively unimportant items. The amount of time spent finding and evaluating substitutes and the inconvenience caused by doing without, are seldom worth the savings achieved. The third element considers whether the good or service purchased is

considered a necessity or luxury. Habitability items are sometimes considered luxuries and are left to be performed by the ship's crew. System repairs and inspection requirements are obviously necessities leaving little choice for the consumer. The final consideration is the time available to adjust to a pricing change. With enough time, alternate sources or substitutes can often be found. However, time is seldom available when systems fail on a combatant or primary support ship. Repairs must be made as soon as possible to maintain battle readiness against the possible outbreak of hostilities. A ship captain does not have the choice to operate with limited capability while searching out a better deal. While some item sourcing could be investigated for future usage, artificial restrictions and lack of information sources often hamper this effort.

One area of debate in the effort to reform government operations is the extent to which market choice will exist in the system, and to what degree it should. Without reasonably elastic demand curves, there is little market incentive for monopolistic or oligopolistic providers to produce at the lowest possible cost. In this case, cost minimization requires competition between suppliers. The DBOF Implementation Plan Report [6] describes a system in which individual program managers and other customers make decisions such as selecting among alternative goods and services, choosing from competitive sources and making repair or replace decisions based on cost effectiveness. For this to occur, two things must happen.

First, operational commanders and program managers must be given the ability to choose. Currently, no Commanding Officer is allowed to take a ship into drydock at Yokosuka because the service is better than at Guam. Further, no program manager can select subcontractors or parts providers. He must rely on a host of supply corps personnel to release bids according to strict guidelines and accept the outcome. Without choice, the system has little elasticity and little incentive to improve.

Secondly, activities must be expected and allowed to fail. If a firm is not permitted to be put out of business, then customers clearly are not free to select the best of competitive alternatives. If an

activity is not allowed to fail, there is no guarantee it is competing equally in a market, and the greatest efficiency is not being achieved.

In addition to motivating cost savings, competition for business and the threat of closure would act to enforce standards of quality. In the oligopolist model, competing in terms of quality and service are preferred to cost competition. Freeing the system to act on these incentives would eliminate the need for costly and less effective regulations and controls. It seems highly improbable, however, that the military will let the "vagaries" of the marketplace determine force structure. It seems even less probable that congress will do so.

B. VARIABILITY

If there is one particular aspect of the unit cost system which is more troubling than any other: the issue of variable budgets. The Guidance [3] states that budget reviewers will require work-load estimates on which to base the distribution of overhead when calculating unit cost goals. Those unit cost goals will then be the mechanism for providing funding and will serve as administrative limitations for the execution of budgetary resources. Budget resources will be "earned" by multiplying a designated output measure by the unit cost goal. The result is that budget authority is not fixed, but varies with work load. This has ominous implications for comptrollers who will now be liable for Article 1517 violations as budget authority varies while the majority of their costs do not. It seems that the management at an activity with decreasing workload is at significant risk.

Because the DOD operates within overall fiscal constraints, there are times when it will not be possible to fund activities at the full level they have earned. This means that managers are not only at risk due to workload fluctuations, but also due to unexpected budget marks. The comptroller at Mare Island confirmed the difficulties of dealing with such a situation. As the unit cost letter was being readied for distribution, Mare Island had just been notified of almost $273 million worth of budget marks for fiscal year 1993. As they were attempting to deal with this cut, the shipyard was

still awaiting guidance on how adjustments to the budget would be made to compensate for volume fluctuations. All of this occurred under the cloud of article 1517 limitations, which limited the budget options available.

Noting that the budget process usually lags the planning process by a fair amount, it seems that leadership in the future will largely consist of contorting plans and actions to fit continuously-changing budget situations. Not only will this detract from other vital performance concerns, but it will also lead to the squandering of resources as coherent long-term plans are continually laid to waste.

The DBOF Implementation Plan Report [6] addresses this issue. Paragraph II.C. in the DBOF overview section states that while the overall utilization of resources is naturally determined by the level of customer orders, each manager will be expected to maintain costs below the product of his assigned unit cost goal and the level of customer work load. In short, this assumes that the unit cost curve is flat and does not allow for variances. It has already been shown that this assumption is incorrect as the unit cost curve is usually modelled as having a "U" shape. This policy is described as an improvement for industrially funded activities in section IV.B.1. of the same document. This section further states that these goals may be set at the Department level, far from the realities which drive daily decision-making.

While shipyards participate in the Fleet Scheduling Conferences, they have little control over changes which can greatly affect their workload. "Puts" and "takes" are supposed to be credited for workload adjustments, but shipyards are not yet sure how they will be credited by the Navy Comptroller (NAVCOMPT). The only discussion of this topic found is in the DBOF Implementation Plan Report [6] which mandates determining profits or losses at the end of a fiscal year and reflecting those amounts in price adjustments to the customer for the following year. This means that uncontrollable workload shifts and the resulting funding shortfalls can reduce the future competitiveness of an activity. This has potentially large repercussions as more public vs. private

competition awards are made. The trend toward competitive award of ship overhauls is already visible in east coast submarine SRA's. This leads to interesting questions regarding gamesmanship in competitive bids. It may be advantageous for a private shipyard to accept a short-term loss if it can win contracts away from Navy sources. As the volume of work decreases at the Navy shipyards, their future year unit cost goals will rise making them less competitive for future contracts.

Additional problems are evident from examining the new budget submission process. Budget submissions, as well as approved goals, will be expressed in unit cost terms. Unless the determining agency is extraordinarily diligent in separating fixed from variable costs, budget marks in unit cost terms could have much greater effects than anticipated. Further, variances in estimated workload will have a much greater effect. Assuming 15% of the costs are variable, a ten-percent error in predicted work-load at the Mare Island shipyard should cause a 1.5 percent error in funding. This assumes that fixed costs are historically documented, and that budget negotiations are at the margin for work-load and productivity. With unit costing, however, the same ten-percent error in workload projection would result in a full ten-percent funding error. While higher authority would undoubtedly act to mitigate the effects of this error, it seems doubtful that resources will be available to cover budgets almost seven times as volatile as current budgets. This will undoubtedly lead to special resolutions and embarrassment for the military and the executive branch of government.

Finally, operational budgets will be funded on a cost basis, rather than an obligation basis. However, with externally imposed appropriation limitations, separate obligation limits may be necessary for some functions. With multiple forms of financial tracking, it seems we are either greatly increasing the workload on our supply officers, even as we strive to reduce their number, or we are forcing everyone in the Navy to become an accountant. Work centers track obligations. Outlays may occur over an uncontrollably broad range of time. As budget execution becomes bogged down in disputes over BA, outlays, costs and confusion regarding available funding, productivity will inevitably decline as mistakes increase.

C. EVALUATION

Great care must be taken when attempting to use unit cost data as an evaluation tool. To be meaningful, a manager must have control over the labor, equipment and facilities used in production. Without these controls, deficiencies identified through unit cost differentials may reflect only the boundaries of the environment rather than the skills of the manager. Permanent facilities, capability requirements and labor contracts often leave management with few options to reduce cost. Under these circumstances, a manager risks being evaluated on the firm's production function rather than his performance.

The Unit Cost Resourcing Guidance [6] states that cost center managers should only be held accountable for costs they are aware of and have some influence over. Given the shipyard example presented earlier, where 85 percent of the activities costs were uncontrollable, it would seem that unit cost will provide little data for evaluating the performance of management. Further, the Unit Cost Resourcing Guidance [6] states that activities must still be responsive to corporate policy, even if that policy increases their unit cost. While unit cost encourages management to look at all overhead, including capital costs, in terms of the output, commanders will have little control over these costs. Given these environmental restrictions, it seems unit cost data is ill suited for the stated role of performance evaluation.

V. CONCLUSIONS AND RECOMMENDATIONS

The unit cost system is much more than a new budget tool. By attempting to alter the decision-making process of military management, it is altering the economic model under which military activities operate. Incorporating performance measurement and evaluation into the system adds personal incentive to the market forces affecting system managers. Both opportunities and concerns come with this new, or at least altered, economic model.

Operating in the oligopolistic model, the competition between suppliers embodied in the unit costing initiatives have great potential to reduce cost and improve quality. Focusing on a naval shipyard as an illustration, increased competition, such as is occurring in East Coast SRA's, encourages activities to lower cost. Further, in the oligopolistic model, competition is more likely to occur on the basis of quality and service. While external mechanisms exist in the shipyard case to insure quality, this effect can save on the costly regulations and controls required on other producers.

Unfortunately, there is doubt as to how much the final implementation of unit cost will resemble a free market. By centrally dictating prices through unit cost goals and forcing shipyards to accept all work at this price, the ability of supply and demand to insure efficient production has been lost. Without this market interaction, the incentive to improve quality is also lost. Not only does this require maintaining cumbersome quality control systems, but these systems must be expanded as the incentive exists to reduce quality to achieve unit cost savings.

Additional questions regarding incentives evolve from unit costing's treatment of variable budgeting and personal performance appraisal. Determining future year pricing based on past year performance does not promote efficient production and risks a dangerous round of gamesmanship with private shipyards as consolidations and workload reductions strain profitability. Linking performance appraisal to budget results risks forfeiting long-term considerations such as R&D for

short-term unit cost reductions. It also appears to be of questionable value for this purpose as results may reflect an activities production function and external constraints, rather than the capabilities of management.

In addition to these concerns are questions regarding the suitability of unit costing to the military environment. If the data generated is used in a manner inconsistent with economic theory, great damage could be done. This was demonstrated in the examples comparing ATC and marginal cost as a basis for reallocation decisions. Improper measures of effectiveness and improper comparison of results can defeat the very purposes of the system.

While the promise of free market reforms is alluring, the unit cost system, as currently structured, could do more harm than good. Without strong commitment to allow full free-market action in all areas of service, potential gains will always be limited and additional programs will be necessary to maintain quality. Significant risk is fostered by allowing only partial competition and limiting government activities through such actions as dictating pricing and volume. It seems that a preferable course of action would be to either remain safe and maintain central control, or to throw open the doors to the potential gains of free market action. By attempting to do both, unit cost risks doing neither, giving up safety without the promise of large savings.

At this time, the unit cost system is still being revised. Shipyards have not yet received much unit cost guidance, and many planned improvements to the system have not yet been implemented. As a result, comparative budget data to investigate changes under unit costing was not available. A follow-on examination of how unit costing is implemented in the shipyard environment would provide a good area for future study. Of particular interest is the degree to which free market action will be allowed, and how steady-state operation under unit costing affects repair or replace decisions and workload breakdown and distribution.

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